

## Supplementary

**Table 1: Included studies characteristics**

#	Author and year	Place	Title	Design	Variable	Conclusion
1	Dib et al, 2009	KSA	Improvement in vancomycin utilization in adults in a Saudi Arabian Medical Center using the Hospital Infection Control Practices Advisory Committee guidelines and simple educational activity	Quasi-experimental	Inappropriate, IM, CC, Oncology and Surgery	Effective methods to decrease inappropriate vancomycin usage are educational efforts with chart review and feedback to the Physician.
2	Youssif et al, 2017	KSA	Retrospective evaluation of piperacillin–tazobactam, imipenem–cilastatin and meropenem used on surgical floors at tertiary care hospital in Saudi Arabia	Retrospective	Inappropriate, Surgery	Broad-spectrum antibiotics use is unjustified and needs interventions like culture and sensitivity test requests within 24 h of starting the broad-spectrum antibiotics and de-escalation.
3	Hammuda et al, 2013	Qatar	Point prevalence survey of antimicrobial utilization in oncology patients	Retrospective	Inappropriate, Oncology,	Broad-spectrum antibiotics are frequently used and need antimicrobial stewardship programs.
4	Al-Maliky et al, 2017	Oman	Evaluation of antibiotic prescribing for adult inpatients at Sultan Qaboos University Hospital, Sultanate of Oman	Observational	ICU, Inappropriate	The diagnosis documented in 89%, and compliance with SQUH antibiotic prescribing guidelines was suboptimal. Studies are required to cope with the reasons behind the non-compliance with guidelines.
5	Aseeri, 2013	KSA	The Impact of a Pediatric Antibiotic Standard Dosing Table on Dosing Errors	Retrospective	Pediatric	Implementation of dosing standard in the pediatric department reduces the dosing errors.
6	Khan et al, 2012	Qatar	Evaluation of the use of piperacillin/tazobactam (Tazocin®) at Hamad General Hospital, Qatar:  are there unjustified prescriptions?	Retrospective	Surgical,	The study shows that the use of piperacillin/tazobactam at our hospital was unjustified, evidenced inappropriate empiric prescriptions and inappropriate drug modifications, depends upon the microbial cultures.

7	Alahdal et al, 2012	KSA	Evaluation of applying drug dose adjustment by physicians in patients with renal impairment	Retrospective	Medical ward, Renal dose Adj	Physicians are not taking care of dose adjustment in renal failure patients need clinical pharmacist interventions and education to prescribers.
8	Al-Yamani et al, 2016	Oman	Patterns of Antimicrobial Prescribing in a Tertiary Care Hospital in Oman	Retrospective	Acute care, AB Selection	Misuse and overuse of antibiotics prove that need National guidelines. Antibiotics prescribing in different hospitals need to evaluate.
9	Naeem et al, 2018	KSA	Prescribing Empiric Antibiotics for Febrile Neutropenia: Compliance with Institutional Febrile Neutropenia Guidelines	Cross sectional	Oncology, Compliance	FN management guidelines not following in our institute. Appropriate empiric antibiotic indications and doses as per institutional guidelines recommended.
10	Alhameed et al, 2019	KSA	Bridging the Gap between Theory and Practice;the Active Role of Inpatient Pharmacists in Therapeutic Drug Monitoring	Quasi-experimental	Emergency, Medical, surgical, optimal initial dosing	The study highlights the importance of Therapeutic drug monitoring led by the pharmacist to optimize the initial dose of antibiotics.
11	Butt et al, 2016	Qatar	Antibiotic prescription patterns for upper respiratory tract infections in the outpatient Qatari population in the private sector	Retrospective	All specialties	Inappropriate antibiotic prescription for acute URIs is very high in the private health sector in Qatar. Interventions required to reduce inappropriateness.
12	Al-Hadithi et al, 2020	Oman	Evaluation of the appropriateness of meropenem prescribing at a tertiary care hospital: A retrospective study in Oman	Retrospective	Oncology, Haematology, indication of meropenem	Meropenem orders are highly inappropriate and unjustified by culture results that need proper guidelines and education to stop, deescalate and judicious use of meropenem.
13	Alzahrani et al, 2020	KSA	Inappropriate Dental Antibiotic Prescriptions:Potential Driver of the Antimicrobial Resistance in Albaha Region, Saudi Arabia	Retrospective	dental	Some dental prescriptions are unnecessary and need interventions to reduce the inappropriateness.
14	Alanazi et al, 2018	KSA	An evaluation of community-acquired urinary tract infection and appropriateness of treatment in an emergency department in Saudi Arabia	Cross-sectional	Emergency department, inappropriateness	The emergency department of Saudi Arabia revealed highly inappropriate use of antibiotics for UTI.

15	Najdi et al, 1988	Kuwait	Antibiotic misuse in a pediatric teaching department in Kuwait	Retrospective	Inappropriate, pediatric	High rate of antibiotic use and misuse reported due to lack of policies and procedures worldwide.
16	Alanazi et al, 2015	KSA	Prevalence and predictors of antibiotic prescription errors in an emergency department, Central Saudi Arabia	Cross-sectional	Inappropriate, all emergency department	The emergency department shows many errors in prescribing antibiotics, and errors were common with the narrow spectrum and UTI infections.
17	Aly et al, 2012	Kuwait	Audit of Physicians' Adherence to the Antibiotic Policy Guidelines in Kuwait	Retrospective	Adherence, hospital department	Adherence to the antibiotic policy guidelines is very low. Antibiotics were prescribing practice of Physician need to overlook. The recommendation is to follow the policy.
18	Tolba et al, 2018	KSA	An observational study of perioperative antibiotic-prophylaxis use at a major quaternary care and referral hospital in Saudi Arabia	Retrospective	Surgical, inappropriate	In surgical antibiotic prophylaxis, the difference of practice and guidelines does exist and need to follow up the guidelines.
19	Apisarnthanarak et al, 2015	2015 Thailand	Design and analysis of a pharmacist-enhanced antimicrobial stewardship program in Thailand	Prospective	Inappropriateness,	The study suggests better outcomes with IDCP training and incorporation of pharmacist in the stewardship.
20	Arensman et al, 2020	2020 USA	Impact of Mandatory Infectious Diseases Consultation and Real-time Antimicrobial Stewardship Pharmacist Intervention on Staphylococcus aureus Bacteremia Bundle Adherence	Retrospective	Inappropriateness,	The addition of AMS pharmacist review to mandatory infectious disease consultation impacts the outcome measures of stewardship.
21	Baker et al, 2012	2012 USA	Pharmacist-managed antimicrobial stewardship program for patients discharged from the emergency department	Retrospective	Inappropriateness	An Eph-managed antimicrobial stewardship program significantly reduced time to the culture that affects the appropriate prescribing.
22	Bessesen et al, 2015	2015 USA	Antimicrobial Stewardship Programs: Comparison of a Program with Infectious Diseases Pharmacist Support to a Program with a Geographic Pharmacist Staffing Model	Retrospective	Inappropriateness,	Pharmacist, through stewardship responsible for better antibiotic prescribing measures and conversion from parenteral to oral therapy.

23	Brizzi et al, 2020	2020 USA	Impact of Pharmacist-Driven Antiretroviral Stewardship and Transitions of Care Interventions on Persons With Human Immunodeficiency Virus	Retrospective	Inappropriateness	A pharmacist-led ARV stewardship and TOC program impacts prescribing practice and readmissions.
24	Burns et al, 2020	2020 USA	Implementing outpatient antimicrobial stewardship in a primary care office through ambulatory care pharmacist-led audit and feedback	Retrospective	Inappropriate	An ACP-led ASP intervention within a primary care office incorporating audit and feedback improved antibiotic prescribing practice for URIs and UTIs, including duration of therapy.
25	Cappelletty et al, 2013	2013 USA	Evaluating the impact of a pharmacist's absence from an antimicrobial stewardship team	Retrospective	inappropriateness	Inappropriate prescribing increase with the absence of a pharmacist.
26	Dolgova et al, 2019	2019 Spain	Pharmacist recommendations for Carbapenem de-escalation in urinary tract infection within an antimicrobial stewardship program	Prospective	Inappropriateness	Carbapenem de-escalation under pharmacist recommendation proves a positive intervention that can help to reduce mortality, inappropriateness and readmission.
27	Fay et al, 2019	2019 USA	Pharmacist-led antimicrobial stewardship program in an urgent care setting	Retrospective	Inappropriateness	A pharmacist-led urgent care ASP was associated with a reduction in inappropriate prescribing and readmission.
28	Giruzzi et al, 2019	2019 USA	Evaluation of Antibiotic Utilization in an Emergency Department After Implementation of an Antimicrobial Stewardship Pharmacist Culture Review Service	Retrospective	Inappropriateness	ASP pharmacist evaluation of positive cultures in the ED has a positive impact on reducing the time to appropriate therapy.
29	Haque et al, 2017	2017 Pakistan	Impact of pharmacist-led antibiotic stewardship program in a PICU of low/middle-income country	prospective	inappropriateness	The study shows the Impact of pharmacist on cost, consumption, mortality and inappropriate antimicrobial prescribing.
30	MacMillan et al, 2019	2019 Canada	Evaluation of a pharmacist-led antimicrobial stewardship service in a pediatric emergency department	Retrospective	Inappropriateness	Although this pharmacist-led AMS program did not affect the readmission, it may have led to much better result on inappropriate prescribing.

31	Ohashi et al, 2018	2018 Japan	Evaluation of treatment outcomes of patients with MRSA bacteremia following antimicrobial stewardship programs with pharmacist intervention.	Prospective	inappropriateness	The use of an appropriate bundle, established by an AST with pharmacist intervention, can affect the treatment of MRSA-B and Impact other outcomes significantly.
32	Samura et al, 2019	2020 Japan	Support for fungal infection treatment mediated by pharmacist-led antifungal stewardship activities	Retrospective	inappropriateness	These results suggest that pharmacist-led antifungal stewardship positively impacts outcome measures like cost, consumption, and mortality.

Table 2: shows the studies quality assessment through JSM tool.

S N	Study Name	Scale Items <sup>a</sup>												Score
		1	2	3	4	5	6	7	8	9	10	11	12	
1	Dib et al, 2009	Y	Y	Y	Y	CD	Y	Y	N	NR	Y	Y	Y	L
2	Youssif et al, 2017	Y	Y	Y	Y	Y	Y	Y	NR	NR	Y	Y	N	L
3	Hammuda et al, 2013	Y	Y	Y	Y	N	Y	Y	NR	NR	Y	Y	CD	M
4	Al-Maliky et al, 2017	Y	Y	Y	Y	NR	Y	Y	NR	CD	Y	Y	NR	M
5	Aseeri, 2013	Y	Y	Y	Y	CD	Y	Y	CD	Y	Y	Y	NR	L
6	Khan et al, 2012	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	NR	CD	L
7	Alahdal et al, 2012	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	CD	NR	L
8	Al-Yamani et al, 2016	Y	Y	Y	Y	CD	Y	Y	Y	CD	Y	CD	N	M
9	Naeem et al, 2018	Y	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	Y	L
10	Alhameed et al, 2019	Y	Y	Y	Y	Y	Y	Y	NR	CD	Y	Y	N	M
11	Butt et al, 2016	Y	Y	Y	Y	NR	Y	Y	N	NR	Y	Y	N	M
12	Al-Hadithi et al, 2020	Y	Y	Y	Y	CD	Y	Y	CD	NR	Y	Y	Y	L
13	Alzahrani et al, 2020	Y	Y	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	L
14	Alanazi et al, 2018	Y	Y	Y	Y	Y	Y	Y	Y	NR	Y	NR	NR	L
15	Najdi et al, 1988	Y	Y	Y	Y	Y	Y	Y	Y	NR	Y	NR	NR	L
16	Alanazi et al, 2015	Y	CD	Y	Y	Y	Y	Y	CD	Y	Y	Y	Y	L
17	Aly et al, 2012	Y	Y	Y	Y	N	Y	Y	CD	NR	Y	NR	Y	M
18	Tolba et al, 2018	Y	Y	Y	Y	N	Y	Y	NR	CD	Y	NR	Y	M
19	Apisarntharak et al, 2015	Y	Y	Y	Y	CD	Y	Y	N	CD	Y	Y	N	L

20	<b>Arensman et al, 2020</b>	Y	Y	Y	Y	Y	Y	Y	NR	CD	Y	Y	N	<b>L</b>
21	<b>Baker et al, 2012</b>	Y	Y	Y	Y	CD	Y	Y	N	Y	Y	Y	N	<b>L</b>
22	<b>Bessesen et al, 2015</b>	Y	Y	Y	Y	N	Y	Y	NR	Y	Y	N	CD	<b>M</b>
23	<b>Brizzi et al, 2020</b>	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	CD	<b>L</b>
24	<b>Burns et al, 2020</b>	Y	Y	Y	Y	Y	Y	Y	NR	CD	Y	Y	N	<b>L</b>
25	<b>Cappelletty et al, 2013</b>	Y	CD	Y	Y	CD	Y	Y	NR	CD	Y	Y	N	<b>M</b>
26	<b>Dolgova et al, 2020</b>	Y	Y	Y	Y	Y	Y	Y	NR	CD	Y	Y	Y	<b>L</b>
27	<b>Fay et al, 2019</b>	Y	Y	Y	Y	Y	Y	Y	NR	NR	Y	Y	CD	<b>L</b>
28	<b>Giruzzi et al, 2019</b>	Y	Y	Y	Y	Y	Y	Y	NR	NR	Y	CD	Y	<b>L</b>
29	<b>Haque et al, 2017</b>	Y	Y	Y	Y	CD	Y	Y	N	NR	Y	N	Y	<b>M</b>
30	<b>MacMillan et al, 2019</b>	Y	Y	Y	Y	Y	Y	Y	CD	NR	Y	Y	Y	<b>L</b>
31	<b>Ohashi et al, 2017</b>	Y	Y	Y	Y	Y	Y	Y	Y	NR	Y	NR	Y	<b>L</b>
32	<b>Samura et al, 2020</b>	Y	Y	Y	Y	Y	Y	Y	N	NR	Y	NR	Y	<b>L</b>

**PRISMA Checklist**

Section/topic	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	no
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	3-5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	3-5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	3 Appendix
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	3-5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	3-5

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Table 2
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	3-5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ ) for each meta-analysis.	3-5

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Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Figure 4 & 5
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	No additional analysis
<b>RESULTS</b>			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Table 2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Table 1 and 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	10-15
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Figure 4&5
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	No additional analysis
<b>DISCUSSION</b>			



Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	15-17
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17
<b>FUNDING</b>			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	No funding

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 6(7): e1000097. doi:10.1371/journal.pmed1000097

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